

**INTERNATIONAL CO-OPERATION IN THE SUPPLY  
OF NUCLEAR FUEL CYCLE SERVICES**

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in these two important areas of the fuel cycle it seems that international collaboration is the appropriate strategy because of the size of the plants needed for economic operation when compared with most domestic markets, the technical complexity of the operations and cost of developing them, the relatively high cost of the facilities involved and the long lead times needed to construct them.

One other area of the fuel cycle in which international collaboration has evolved, but for slightly different reasons, is uranium supply. In order that individual nations without native uranium resources may proceed with the further development of nuclear-generated electricity they have to ensure that uranium supplies will be available from the relatively few areas of the world in which substantial deposits of uranium have been discovered and to encourage further exploration for uranium in other parts of the world.

Political considerations inevitably require that nations co-operate in the implementation of measures to stem the proliferation of nuclear weapons. It is probably this aspect of nuclear power which currently dominates world thinking on nuclear energy. Proliferation issues cannot be divorced, however, from the more general question of the acceptance of nuclear power by the world's population at large. Recent developments have clearly demonstrated that for various reasons individual national policies towards nuclear power have repercussions throughout the world. There is for all of us who believe that the long-term wellbeing of mankind is a strongly linked to the widespread adoption of nuclear power to meet growing demands for energy a moral obligation to work together to ensure that a responsible approach is made in dealing with the potential dangers of this source of energy so that short-term, nationalistic policies do not jeopardise the longer term energy requirements of the world.

## 1. INTRODUCTION

In recent years there has been an increasing tendency for organisations involved in fuel cycle activities, whether Government or privately-financed, to enter into collaboration agreements. There are a number of sound commercial reasons for this, some of which are common to other large, technologically based projects being undertaken on an international scale. There are also a number of other factors, principally of a political nature, which undoubtedly relate to the unique nature of the business in which we are involved.

The two main areas of the fuel cycle business in which collaborative agreements have been successfully established are reprocessing and enrichment. The obvious examples in the reprocessing field are Eurochemic and United Reprocessors GmbH, and in enrichment Eurodif and the tri-national Urenco/Centec organisation. As in all businesses those national entities involved in reprocessing and enrichment have been faced with two fundamental alternatives - direct competition or some form of international collaboration. At a time when it is essential for strong, viable industries to be established

This paper develops these points based on the specific experience of BNFL.

## 2. THE COMMERCIAL INCENTIVES FOR INTERNATIONAL COLLABORATION

The sudden and dramatic world-wide increase in oil prices in October 1973 came as a rude but perhaps salutary shock to the Western World. It emphasised that there are limited resources of oil in the world, and that mankind must turn to other fuels and strict energy conservation in order to meet the growing world demand for energy. Oil-producing countries recognised that in order to ensure the long-term economic development of their countries both the supply of oil and the price asked for it should be regulated for as long as the resources lasted.

These events and subsequent developments have emphasised that nuclear generated electricity is an option which must be developed. In order to service the World's growing nuclear programme substantial investment decisions will be required to develop and build the necessary facilities and to ensure that a strong, viable nuclear fuel service industry

**TABLE I. PERCENTAGE BREAKDOWN OF NUCLEAR GENERATING COSTS AND INVESTMENT IN PLANT**

	<u>Total Operating Cost</u>		<u>Total Investment in Plant (per kW operating capacity)</u>	
Reactor and associated plant	73%		90%	
Fuel Cycle	27%		10%	
	100%		100%	
	<u>Nuclear Fuel Cycle Operating Costs</u>		<u>Investment in Nuclear Fuel Cycle Plants (per kW operating capacity)</u>	
Uranium	13%	49%	2%	20%
Enrichment	9%	33%	4%	40%
Fabrication	3%	10%	1%	10%
Reprocessing/				
Waste Management	4%	15%	3%	30%
U Credit	- 2%	- 7%	-	-
	27%	100%	10%	100%

is established throughout the world. Even though the investment in the fuel cycle represents only a small proportion of the total investment in nuclear power (see Table I) the market size in relation to the facilities required for economic operation and the other associated risks make co-operation attractive commercially. Indeed, except in a few isolated cases, it is unlikely that one nation's demand for enrichment and reprocessing services will be sufficient to justify on economic grounds the investment required for these facilities.

It is not unusual for investment decisions in a fuel cycle plant to have to be taken five to ten years in advance of its initial operation, and an assured economic utilisation of the plant for the following ten years is required if the investment is to be justified on commercial and financial grounds. There is invariably a high degree of uncertainty associated with forecasts of plant utilisation this far into the future but market risks can be offset by reducing dependence on the vagaries of one nation's energy policy.

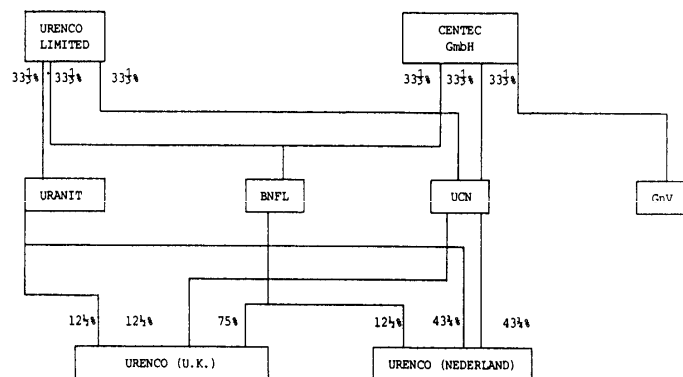
Collaboration involves exchange of technological information and know-how. Development is more efficient and comprehensive so that suppliers have greater assurance that the processes and equipment ultimately employed are the best available. By reducing risk, by increasing the scale and by widening the technological base of an operation, international co-operation leads to more economic operations.

### 3. THE URENCO/CENTEC ORGANISATION AND UNITED REPROCESSORS GmbH

Urenco/Centec is a trinational organisation involving United Kingdom, Netherlands and Federal German companies operating under the auspices of their respective Governments. The organisation is devoted to the development and exploitation of gas centrifuge technology for enrichment of uranium and involves two companies, Urenco Ltd and Centec GmbH, but it is run as a single entity. United Reprocessors GmbH is an international venture for

**TABLE II. REPROCESSING PLANTS FOR OXIDE FUEL**

	<u>Forecast capacity (tU/a)</u>	
	<u>by 1985</u>	<u>by 1990</u>
USA	1,000	3,000
UK	100	1,000
FRANCE	800	1,600
F.R. GERMANY	-	1,400
BELGIUM	60	300
JAPAN	200	1,700
OTHER	-	700
	2,160	9,700



**FIG.1. URENCO/CENTEC - basic organization.**

fuel reprocessing. In both cases the United Kingdom participation in the companies or partnerships involved is through British Nuclear Fuels Limited.

Both organisations were formed because it was recognised by the respective shareholders that collaboration was essential in order to establish viable industries in these two important sectors of the nuclear fuel cycle. In the case of Urenco/Centec the industrial interests concerned saw that the development of a commercially successful centrifuge technology would be both lengthy and costly and that the enrichment market could be very competitive. In setting up the original Urenco/Centec organisation it was the intention to move rapidly towards a single line of development for exploitation on a centralised basis, thereby rationalising the deployment of resources in the three partner countries, by the complete and free exchange of technical information, forward development plans, economic studies and actual costs of plant etc..

However, soon after the original Urenco/Centec structures had been established in 1971 it became clear that, whilst considerable concentration and narrowing down of development objectives was possible and that great benefit was derived from the interflow of information, there was more than one well-established technology which merited continuing development. This, and the vast amount of money involved in investment decisions, led to the conclusion that a looser structure was required, at least for the time being. The change, introduced in 1974, has worked well and there has been excellent technical and commercial collaboration. It is outlined in Fig I. Under the arrangement each shareholder is responsible for his own development programme but judges it in the light of complete and free exchange of information, and as controlling shareholder in each national enterprise determines the extent of major investment in plant he is prepared to make and what technology he will use. Under this arrangement technological development has flourished and a reasonably high degree of unification and standardisation has been achieved.

An apparent surplus of reprocessing capacity developed during the 1960's (mainly because of the reduced military programmes) and the potential capacity situation with new plants under construction or planned in the USA, UK, France and F.R. Germany, indicated an even larger surplus. Following the recommendations of a special Foratom Study Group that there should be international collaboration to rationalise investment in order to establish a viable industry in Europe, UK, French and Fed. German reprocessing interests

(BNFL, CEA (now COGEMA) and KEWA) joined together and formed United Reprocessors GmbH. The company also became the repository for all the technical know-how of the shareholders, who had agreed to make it freely available to each other. The sharing of technology has worked to the advantage of all the shareholders, and the co-operation of the R&D programmes will ensure that the designers of the new plants will be provided with the best information at minimum cost and duplication of effort.

The United Reprocessors' Agreement and collaboration has proved to be flexible in the changing circumstances surrounding reprocessing. Each partner is responsible for the construction of plants in his own country but there is consultation and co-ordination of the schedule of investment particularly for capacity installed for external business. The timing and expected capacity of commercial reprocessing plants throughout the world is surrounded by many uncertainties, but Table II summarises current plans. There is clearly going to be a shortage of capacity in the 1980's and substantial quantities of fuel will have to be stored in ponds prior to eventual reprocessing. The Shareholders of United Reprocessors are planning their capacities of both storage ponds and reprocessing plants accordingly, but as is well known they will not invest in plants for external business without long-term commitment by the customers, together with substantial pre-payments to help finance construction of the plants.

To establish and operate multinational organisations smoothly and efficiently raises many problems. Efficient mechanisms have to be established for speedy consultation and decision making if the venture is to achieve its commercial objectives and maintain sufficient momentum. The individual parties must be allowed sufficient flexibility to control their construction, production and development programmes and commercial policy whilst at the same time ensuring a high degree of co-ordination. All these require patience, objective thinking and above all good-will and therefore a clear identity of interests.

#### 4. OTHER COMMERCIAL CONSIDERATIONS

Other problems which have to be considered in setting up international collaboration agreements, which have been covered to some extent in the references to Urenco/Centec and United Reprocessors, are those related to financial control on an international scale, which may be exacerbated by fluctuating currency exchange rates and differential inflation, and the general allocation, of activities between partners. On this latter point partners have to ensure that fair and equitable rules are established.

For a multinational organisation to be successful there must be clearly identified objectives and a well-defined market. The difficulties of establishing an efficient international organisation and maintaining its smooth running increase with the number of participants. Furthermore, these difficulties are exaggerated if several languages are in use, and it is unfortunately almost axiomatic that if one of the participating organisations is British or American English has to be used as the working language of collaboration.

Before leaving commercial considerations another area of the fuel cycle should be considered. There is a striking disparity in the distribution of uranium supply and demand throughout the world. In attempts to guarantee supplies, utilities have progressively entered into joint ventures

with mining companies and/or other interests in exploration for new reserves and exploitation of known deposits. New organisations, such as the World Nuclear Fuel Market and the Uranium Institute, have been formed to increase flow of information between customers and suppliers, bring customers and suppliers together, and promote improvements in exploration and extraction techniques. Groups of nations or utilities are coming together to ensure a secured share of future uranium supplies for the individual participants concerned.

In the overall fuel cycle it is interesting to note those areas in which international collaboration has proved not to be necessary or desirable, for example fuel fabrication and  $UF_6$  conversion. These do not involve large capital investments or long construction lead times. Furthermore, the technology involved is well established and the international market relatively stable. In the case of fuel fabrication the market has been shaped to a large extent by the often necessary links between reactors and initial fuel charge supply, and by the strong ties that have developed in many countries between utilities and domestic suppliers.  $UF_6$  conversion is a standard business comparable with the supply of any chemical service on a competitive basis.

## 5. POLITICAL CONSIDERATIONS

In considering international co-operation, political requirements are also of high priority. In particular, the spread of nuclear weapons is quite rightly a matter of international concern and multinational organisations must establish procedures to ensure that the dissemination of sensitive information remains under impartial and proper control. It is argued that the setting up of multinational organisations, under direct political control would help stem the proliferation of nuclear weapons and their associated technology and materials. However, it has to be recognised that one of the reasons for nations pursuing the nuclear electricity generating option is their desire for a relatively high degree of energy independence and it is understandable therefore that they may be unenthusiastic about participating in a multinational organisation over which they would not have complete control. These problems seem to have been overcome in the cases of United Reprocessors and Urenco/Centec although it should be recognised that these are organisations based primarily on commercial co-operation. In considering the means of establishing new viable and efficient multinational organisations this should be borne in mind.

There is a strong argument for using established supplier organisations as the basis for international groupings in order to control the spread of nuclear materials and technology. If it is accepted that the widespread use of nuclear power throughout the world is essential for the well-being of mankind then it follows that, rather than restricting the development of a full fuel cycle service, urgent steps should be taken now to establish strong viable fuel cycle service

industries, and supplier nations should work together with customers to arrive at acceptable forms of organisation which will reduce the associated risks of proliferation. In this paper it is not intended to consider in detail the concept of Regional Fuel Cycle Centres (RFCC's) but the work being undertaken in this important area is to be applauded, and indeed the establishment of RFCC's might eventually prove to be the most appropriate strategy. However, it is important to bear in mind that if the world is to have the fuel cycle services which it requires then the associated industries will have to organise themselves so that the services can be supplied efficiently, and in a way acceptable to customers and suppliers alike and which at the same time will reduce the risk of proliferation.

Proliferation is a matter of concern at the present time, particularly in regard to reprocessing and enrichment technology, and it is appropriate in conclusion to consider the position in United Reprocessors and Urenco/Centec. In forming Urenco/ Centec and United Reprocessors, although the motives of the participating organisations were essentially commercial, political pressures, particularly those concerning non-proliferation, have had a major influence on the policies of both organisations. Urenco/Centec was in fact set up under the aegis of an international treaty - The Treaty of Almelo - whilst the activities of United Reprocessors are closely followed, and in political matters influenced, by the three Governments.

In United Reprocessors transactions involving the sale of technical know-how to fourth countries can only be undertaken with the prior unanimous agreement of the shareholders and, in practice, the approval of the individual Governments of the UK, France and Germany has to be obtained by the respective shareholders. (It should perhaps be mentioned that the agreement in this respect excludes supply of information about laboratory scale plants of less than 10 kg uranium throughput per annum (e.g. Brazil) and the French sale to Pakistan was under negotiation before the agreement was promulgated)

The political aspects of the activities of Urenco/Centec and, through the Shareholders Agreement, the activities of the industrial shareholders in the centrifuge field are controlled by a Joint Committee. This has Government representatives from all three countries concerned, and the Chairmanship rotates on an annual basis. Its main aim is the supervision and control of the dissemination of centrifuge technology information as well as the co-ordination of, spending of funds provided by the three Governments. (At present the R&D programmes in all three countries benefit from some degree of Government support although this is decreasing and in the case of the UK BNFL has no support after March 1977.) To these ends the Joint Committee controls classification policy with respect to centrifuge information; accepts responsibility to ensure that the policies of the companies safeguard enriched uranium against diversion; controls dissemination of information to fourth parties, particularly

by requiring Urenco/Centec to submit for its approval all proposals for dealings with fourth countries; and approves R&D programmes and investment proposals of the enterprises and shareholders.

#### 6. CONCLUDING REMARKS

At a time when new, large and technologically complex plants are being developed there are strong commercial and economic incentives for organisations in several countries to enter into collaborative agreements. By this means the technological and market risks associated with the required investments can be effectively reduced. Individual suppliers have tended to follow this path in establishing strong, viable enrichment and reprocessing services to meet the requirements of a growing world nuclear power programme. The multinational organisations which have already evolved in most cases, have operated with a high degree of success. However, circumstances change and these organisations will not remain static and will develop to meet the new situations. This is illustrated by the experience of Urenco/Centec and United Reprocessors. Indeed a time may come when viable industries have been established and there may not be the same commercial incentives for collaboration. But for the immediate future it is likely that the World will see an increasing trend towards international co-operation in the nuclear fuel cycle services industry, to the benefit of customers and suppliers alike.

Growing world concern about the potential dangers of nuclear power has emphasised how individual national policies towards nuclear power are inextricably linked. In particular, the prevention of nuclear weapons proliferation requires that both supplier and customer nations work together to develop realistic and acceptable policies. There is an obligation on those who realise that nuclear power is essential to improve the lot of the greater part of the world's population to ensure that the potential dangers are considered responsibly and that solutions to the problems are found as speedily as possible. Undoubtedly this means international collaboration and one way may be the development of international facilities such as Regional Fuel Cycle Centres. Whatever the ultimate answer there can be no doubt that suppliers of nuclear fuel cycle services have a duty and an important role to play in these deliberations.